

Testis

- A compound tubular, mixed gland w develops retroperitoneally then migrate to Scrotum. Scrotum = pouch of skin e' no fat to maintain the testis at $2-3^{\circ}\text{C}$ below body temp. (essential for spermatogenesis), many eccrine sweat glands & dartos muscle (haphazardly arranged) its contraction leads to wrinkling of scrotal skin

Stroma:

- * Capsule: Formed of 3 coats:

(1) Tunica Vaginalis:

a peritoneal fold brought down during descent of testis to scrotum Formed of: visceral & parietal layers: lined e' s.sq. mesothelium & contains watery fluid → lubricant to allow free movement of testis.

(2) Tunica Albuginea:

A c.t. capsule, thickened posteriorly to form → mediastinum testis.

(3) Tunica Vasculosa: vascular c.t. lining t. albuginea & Septa.

* Trabeculae:

arise from mediastinum testis to divide the testis → 250 compartment [lobules]
Each lobule contains 1-4 Seminiferous tubule + c.t. rich in bl. vs, ns + l. vs + interstitial cells of Leydig.

* Ret.c.t

Parenchyma:

- (a) Exocrine part = Seminiferous tubules → sperms
- (b) Endocrine part = Interstitial cells of Leydig → testosterone.

The Seminiferous Tubules.

- No: 250-1000 convoluted tubules - 30-70 cm long & 200 μm in diameter
- lined e' stratified epith = Spermatogenic epith. formed of 2 types of cells I + II

I. Sertoli Cells:

- the main cells till puberty but after puberty = only 10% of the cells lining the tubules
- not affected by factors affecting spermatogenic cells.

* L.M.

- tall pyramidal cells w extend from the b.m. to the lumen
- have indistinct cell boundaries
- have pale vesicular oval or triangular nucleus e' clear nucleolus.
- have pale acidophilic cytoplasm.

* E.M.

- numerous mitochondria, well developed G.A, abundant s.ER, few rER, lysosomes & free ribosomes & many lipid droplets - well developed cytoskeleton of microfilaments & microtubules to help upward movement of spermatogenic cells towards the lumen.
- the lateral border contain deep invaginations or pockets in w spermatogenic cells lie.
- At the basal parts cytoplasmic extensions from adjacent cells are joined by tight junction [Occluding J.] to divide the seminiferous tubule into basal compartment & adluminal compartment.
- Each Sertoli cell supports 30-50 spermatogenic cell at diff. stages of development.

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• Functions of Sertoli Cells:

1. Supportive & nutritive functions:

- Spermatogenic cells are present inside pockets (invaginations) in their lat. walls.
- Sertoli cells regulate passage of nutrients to spermatogenic cells & transport of waste products to bl. & lymph outside the seminiferous tubules.

2. Phagocytic function:

- digest residual bodies resulting from spermiogenesis.
- ↳ degenerating cells w fail to complete spermatogenesis.

3. Secretory function:

- In σ Embryo: [about 8th or 9th week]:
secrete Müllerian inhibitory substance: inhibits development of Müllerian duct system.
- In prepubertal testis: secrete a substance $\rightarrow$ give σ embryo $\rightarrow$ prevent meiosis of spermatogenic cells.
- In postpubertal testis: secrete:
 - testicular fluid: w carry immotile sperms to the genital ducts. (rich in Fructose)
 - ABP [Androgen Binding ptn] (under control of FSH). ABP combines w testosterone & transport & concentrate it to stimulate spermatogenesis w the tubules
 - Inhibin: inhibit synthesis & release of F.S.H. i.e. inhibits spermatogenesis.

4. Form Blood Testis barrier:

The barrier w separates tissue fluid outside the seminiferous tubules from spermatogenic cells inside it. Formed by: tight junction bet. cytoplasmic extensions at the basal parts of Sertoli cells dividing the tubules into:

- a. Basal compartment (under the barrier): containing only spermatogonia.
- b. Adluminal " " (above " "): " " the rest of spermatogenic cells.

So, tissue fluid can penetrate the b. memb. to reach spermatogonia in the basal compartment & cannot reach the rest of the spermatogenic cells in the adluminal " " except through the barrier (Sertoli cells).

The newly formed 1-2 μ Spermatoocytes disrupt the junction forming the barrier to reach the adluminal compartment after a new junction is formed.

Functions of Blood testis barrier:

1. Selection of nutrients & hormones needed for differentiation of spermatogenic cells.
2. Isolation & protection of spermatogenic cells from any damaging subs in the blood
3. Create special environment in the adluminal compartment rich in Na^+ , K^+ & ABP. needed for proper spermatogenesis.
4. Prevent autoimmune reaction: As spermatogenic cells are formed after puberty, so body's immune system consider them as antigen & produce antibodies (antisperm Immunoglobulins). Bl. test. Barrier prevent passage of these Abs. to sperms.

(1) Spermatogonia: 21. Spermatogenic Cells:

Small cells ($12\mu\text{m}$) rounded cells e' rounded nuclei e' diploid No of chromosomes ($44+XY$). They lie in one or 2 layers on the basement memb. 3 types:

- a. Dark type A: have dark nuclei = Precursor cells: they divide to give 1 additional dark type A (reserve cells) + 1 pale type A = cycling cells.
- b. Pale type A: have pale nuclei = (cycling cells): divide by mitosis to give:
- c. Type B: Similar to pale type A but larger: divide, grow in size & differentiate into:

(2) 1st Spermatocytes:

- The largest cell ($18\mu\text{m}$) arranged in 2 or 3 layers.
- have largest rounded nucleus e' diploid no. of chromosomes = 46. e' prominent coiled chromosomes as they enter the prophase of 1st meiotic division w is very long (22 days). By the end of 1st meiotic division they give rise to 2nd Spermatocytes.

(3) Secondary Spermatocytes:

- Smaller cells e' smaller nuclei
- have haploid No of chromosomes (23) ($22+X$ or $22+Y$)
- difficult to be seen in section as they are short lived & rapidly enter 2nd meiotic division to give spermatids.

(4) Spermatids:

- Very small cells ($8\mu\text{m}$) e' central dark nuclei near the lumen of the tubules.
- Each spermatid by spermiogenesis → mature sperm.
e' no further division

(5) Spermatozoa: ($60\mu\text{m}$ long) formed of:

Head + tail [neck, middle piece, principal piece & end piece] covered e' cell memb & little cytoplasm.

- Head: ($5\mu\text{m}$) = flat, elongated formed of condensed nucleus. It's ant. 2/3 is covered e' head cap [acrosome] rich in hydrolytic enzs. to facilitate penetration of oocyte.
- Neck: short segment: contain 2 centrioles.
- Middle piece ($5\mu\text{m}$) = flagellar axoneme = 9 peripheral doublet microtubules + 2 central singlets surrounded by supporting fibres then by mitochondrial sheath.
- Principal piece ($40\mu\text{m}$) the flagellar axoneme surrounded by supporting fibres.
- End piece ($10\mu\text{m}$) = axoneme only.

Spermatogenesis

The process of formation of sperms:

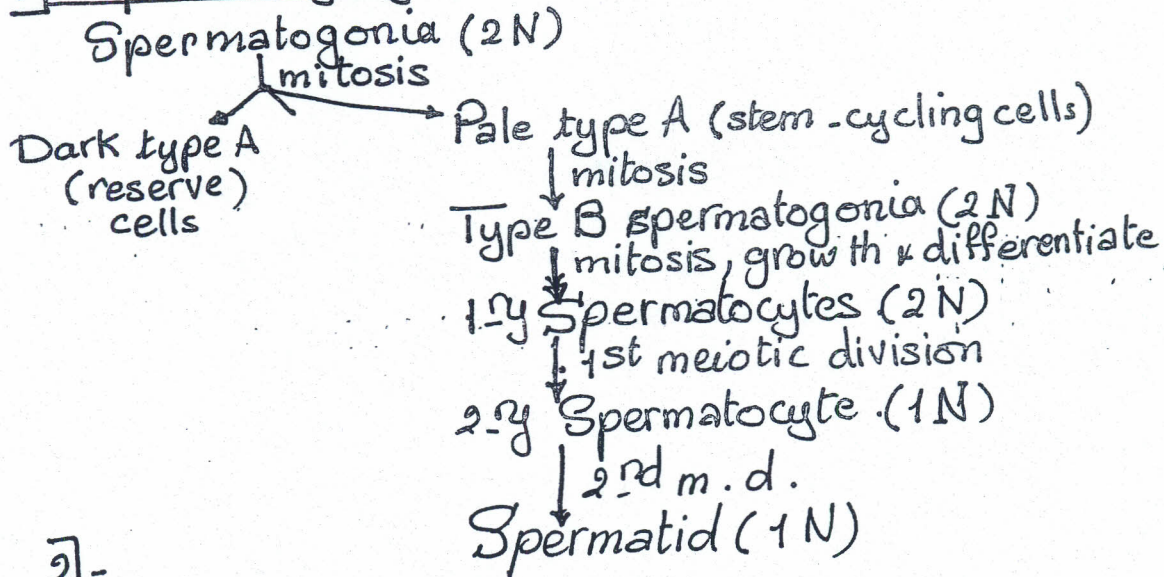
Starts at puberty under control of FSH.

lasts about 64 → 70 days. 2 Stages:

1] Spermatocytogenesis.

2] Spermiogenesis.

1] - Spermatocytogenesis:



2]-

Spermiogenesis:

The transformation of spermatid into sperm by metamorphosis & cell division.

Includes 3 phases:

A] Golgi phase: rER forms hydrolytic enzs. w are modified & packed in G.A. From w memb. bound proacrosomal granules fuse to form a single granule bounded by acrosomal vesicle at one pole while the 2 centrioles migrate to the opposite pole.

B] Acrosomal phase:

- The nucleus elongates, flattens & become condensed.
- the acrosomal vesicle enlarge to cover the ant. $\frac{1}{2}$ of the nucleus & form acrosomal cap.
- One centriole forms flagellar axoneme w become surrounded by supporting ptn. fibres
- mitochondria aggregate around the 9 fibres forming the middle piece where flagellar movement is generated.

C] Maturation phase:

- the acrosomal cap enlarge to cover the ant. $\frac{2}{3}$ of the nucleus $\Rightarrow$ acrosome. w contains (acrosin) hyaluronidase, acid-phosphatase & proteases. When a sperm contacts an oocyte, these enzs digest Corona radiata then zona pellucida to facilitate fertilization.
- Excess cytoplasm pinch off as residual bodies phagocytosed by Sertoli cells.
- newly formed sperms separate from apices of Sertoli cells & lie free in the lumen. (a process called spermiation).

• Acrosomal Reaction:

When a sperm encounter an oocyte, the outer membrane of the acrosome fuses w the cell memb. of the sperm at several sites liberating the enzs in the extracellular space [1st step of fertilization]

• Immotile Cilia Syndrome:

lack of ptns. needed for ciliary & flagellar motility $\rightarrow$

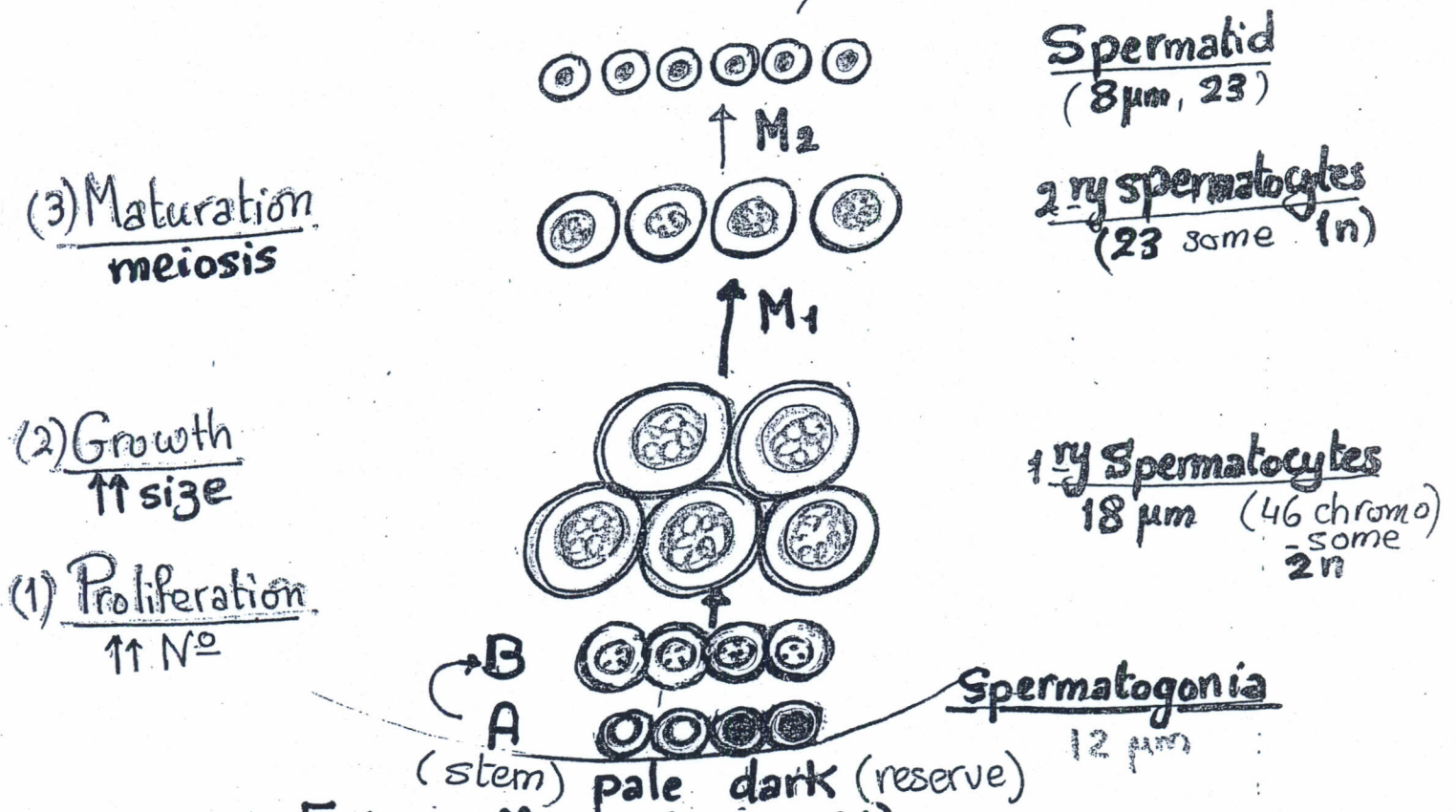
$\rightarrow$ immotile sperms $\rightarrow$ infertility of the affected men.

$\rightarrow$ " " cilia of resp. epith $\rightarrow$ chronic respiratory infections.

Spermatogenesis

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I. Spermatocyto-genesis (1) + (2) + (3) + II. Spermiogenesis
 metamorphosis & out cell division Sperm



Factors affecting Spermatogenesis

(5)

1. Temperature: 35°C is the suitable temp. controlled by:

- presence of testis in scrotum
- pampiniform plexus of veins surround the testicular artery → heat exchange system to lower the temp. of arterial bl. supply of the testis.
- evaporation of sweat from scrotum.
- contraction of cremasteric muscle pulls testis towards inguinal canal in cold weather to ↑ temp & vice versa in hot weather.
- contraction of Dartos ms → wrinkling of scrotal skin ↓ sweat evaporation
- In hot weather it relaxes → stretching " " " ↑ sweat evaporation

2. Hormones:

- L.H. (ICSH) stimulate leydig cells to secrete testosterone.
- Testosterone: stimulate spermatogenesis.
- F.S.H.: stimulate Sertoli cells to produce ABP w accumulate testosterone in the Seminiferous tubules.
- Inhibin: inhibit F.S.H. secretion, so inhibits spermatogenesis.

3. Vitamins: vit. A & E are needed for spermatogenesis.

4. Other inhibiting Factors:

Toxins alcoholism, irradiation, drugs, malnutrition suppress Spermatogenesis

(N.B) Cryptorchidism = failure of descent of testis to scrotum → testicular temp is 37°C this inhibits spermatogenesis & might lead to sterility. So newborns must be checked for descent of testis in scrotum for rapid treatment.

Varicocele = abn. dilatation of pampiniform plexus of veins → fail to $\downarrow$ testicular temp. affecting quantity & quality of sperms.

Interstitial tissue

The spaces bet. seminiferous tubules: contain loose c.t. rich in fibroblasts, macrophages, mast cells + fenestrated capillaries + nerves + lymph vessels + myoid cells + Leydig cells

Myoid cells = flattened contractile cells that surround the tubules. Their contractions propel the non-motile sperms towards rete testis

Interstitial Cells of Leydig:

- endocrine cells separated by fenestrated caps. present in bet. seminiferous tubules
- * • L.M. 14–21 μm
rounded cells w/ central rounded pale vesicular nucleus & clear 1–2 nucleoli
cytoplasm acidophilic & many fat droplets.
- E.M. characters of steroid secreting cells: extensive SER, mit. G.A + many fat droplets
 - ↳ Reinke's crystalloid inclusions of unknown nature seen after puberty & 1st age
 - ↳ lipofuscin granules (esp in old men)
- * • Function: secrete testosterone under control of L.H.
 - testosterone → stimulates spermatogenesis.
 - appearance of 2nd sex characters.
- Leydig cells resist injurious factors e.g. high temp., X-ray etc.

I. Intratesticular ducts:

- ① **Tubuli recti**: straight tubules at the end of the seminiferous tubules, lose spermatogenic cells & lined only by **Sertoli cells** w abruptly → **cuboidal cells**.
 - ② **Rete testis**: network of tubules in mediastinum testis lined by **cuboidal cells** then **c.c.**
- (N.B) the beginning of vasa efferentia is intratesticular but its main part is extratesticular.

II. Extratesticular ducts:

1. **Vasa Efferentia**: 10-20 tubules that enter the head of epididymis lined by **testis-tubed Epith.** = tall col. cil. cells alternating w low col. non-ciliated cells. rests on a clear b.m. surrounded by c.t. & smooth ms. fs.
- Functions**: ① their cilia propel sperms towards epididymis helped by peristaltic contract of their ms. ② Non-ciliated cells absorb some testicular fluid.

2. Epididymis:

- 4-6 meters long, 400 μ m in diameter, highly convoluted → compact organ **7.5 cm** long
- **Formed of**: Head, body & tail. Vasa efferentia enter the head while the tail ends in **vas deferens**.
- **lined by**: **pseudo stratified col. cil & non-motile (stereocilia)** = long microvilli resting on clear basement membrane surrounded by c.t. & smooth ms.
- **E.M.**: cells are rich in rER, well developed G.A, lysosomes + coated vesicles.
- **Functions**:
 1. Absorption of Testicular fluid.
 2. phagocytose & digest residual bodies of spermiogenesis & degenerated sperms.
 3. **Secrete** glycoproteins w help maturation of sperms.
 4. the peristaltic contraction of their muscles propel sperms to the vas.
 5. **Storage & maturation of sperms.**

(N.B) Capacitation:

It is the ability of sperms to reach full maturity, motility & power of fertilization through a series of biochemical reactions. Starts in epididymis, reach its peak in Fallopian tube near the Oocyte.

3. Vas deferens:

Muscular tube 45 cm long, 3 mm in diameter, starts at tail of epididymis & become dilated near its end → **ampulla of vas**. Formed of:

1. **Mucosa**: a- pseudo stratified col. cil & stereocilia w disappears upwards.
b- c.t. corium rich in elastic fibres.

2. **Musculosa**: 3 layers: inner & outer long & thick middle circ. l.

3. **Adventitia**: loose c.t. rich in elastic fs.

Functions: contraction of the thick musculosa → propel sperms to urethra during **ejaculation**

4. Ejaculatory duct:

1 cm Formed by union of the ampulla of vas & duct of the seminal vesicle. Opens into the prostatic urethra. lined by ps. st. col. (non-cil) & no muscles in its wall.

5. Urethra.

Spermatic Cord

(7)

Contains: 1. Vas deferens. 2. Testicular artery 3. lymph vs. 4. nerves
5. pampiniform plexus of veins. 6. Cremasteric ms.: long. involuntary skeletal ms.

♂ Accessory Genital Glands

(1) Seminal Vesicle

2 tubes (15 cm long) coiled on itself → 5-6 cm long body = 3 layers:

A. Mucosa: highly folded =

a. ps. st. col.: by E.M. = pln. secreting cells ^{mit, rER} GA, secretory vesicles. The height & degree of activity depends on testosterone.

b. lamina propria = c.t. rich in elastic fibres.

B. Musculosa: inner circular & out. long.

C. Adventitia: loose c.t. rich in elastic fibres.

Functions: 1. Form 80% of the seminal fluid w̄ is viscid & yellow (lipochroma pig.).
2. their secretion is rich in spermatozoa-activating substances e.g. fructose, d.as. plns., citric A, ascorbic A + prostaglandins & fibrinogen (coagulates semen after ejac.).
3. Fructose is the main nutrient for sperms & give energy for their motility.
4. Contraction of their muscles propel the secretion into the ejaculatory duct.

(2) Bulbo-urethral [Cowper's] glands

2 Compound tubuloalveolar glands (each 3-5 mm in diameter). Present behind the membranous urethra where their ducts open. The acini are lined e' s. cuboidal or s. col. epith w̄ secrete mucous.

The c.t. septa dividing the gl. into lobes & lobules contain **skeletal & sm.ms**

Function: secrete clear mucous (rich in sugars) w̄ precedes the semen.

It has a lubricating function.

Prostate

def. Exocrine, comp. tubulo-alveolar gl. around the neck of Ur. bladder

Stroma:

1. **Capsule**: thick & fibromuscular (rich in sm.ms. & fs).

2. **Trabeculae**: thick, fibromuscular. descend from the capsule to divide the gl. into lobes & lobules.

3. **Ret. c.t.**: ret. cells & fibres in the background. stained e' Ag.

Parenchyma: acini + ducts.

1. **Prostatic acini**: 30-50 arranged in 3 concentric groups around the urethra:

a. **Mucosal Group** (central zone):

Small acini around the urethra where they open directly or by short ducts

b. **Submucosal group** (transition zone):

Medium sized w̄ open by short ducts in the postero-lat. aspect of the urethra

c. **Main group**: (peripheral zone):

Large-sized acini (= 70% of the gl.) w̄ open by long ducts in the post. aspect of urethra

* The acini are lined e' s.col. or ps.st.col. epith e' unclear b.m. & c.t. lamina propria
 N.B. the height of epith. is controlled by the level of testosterone. inadequate level → cuboidal epith (usually in old age).

by E.M: cells show picture of ptn-secreting cells: many mit, well developed G.A. r.ER + secretory granules.

* the lumen of the acini frequently show small mass of glycoproteins (usually calcified) = Corpora amylacea or prostatic concretions Me' age. (unknown) ^{significance}

2. Prostatic ducts: lined e' s. cuboidal or s.col. epith.

Functions:

1. produce thin milky prostatic fluid w give the semen its characteristic Odour
2. the secretion is rich in acid phosphatase, amylase + fibrinolysin w liquify the coagulated semen after its deposition in the vagina to allow free movement of the sperms.

N.B.

- * the mucosal & submucosal groups are the site of benign hyperplasia in old age e' enlarged acini w compress the urethra → difficult micturation & urine retention.
- * the main group: is a major site for cancer prostate w is discovered when advanced being far from the urethra.
- * Prostatic surface antigen (PSA) is a product of the prostate secreted into bl. It's serum level rises in cancer prostate. So it is useful for diagnosis & follow up of the patients

Semen = the thick white fluid released during ejaculation. -

= Sperms + seminal fluid (♂ accessory gls).

Semen analysis: test to measure vol., viscosity, liquification time
 N° & motility of sperms.

Normal values: vol. = 1.5 - 5 ml N° 20 - 150 million/ml. ≥ 60% normal shape & forward motility.

The Penis

-9-

Copulatory Organ covered e' skin (has hairs only at its root) e' no subcutaneous fat: to allow free movement of skin during intercourse. Glands of Littre are present along its whole length (secrete mucous) & open in the urethra.

• Formed of 3 Corpora := erectile tissue =

2 Corpora cavernosa & 1 Corpus spongiosum (through w the penile urethra runs). Corpora cavernosa are covered by thick dense c.t. = Tunica albuginea. While corpus spongiosum is covered e' thin T. albuginea.

The Tunica albuginea is surrounded by fascia penis (under the skin)

• At its end the corpus spongiosum expands → **glans penis**.

The erectile tissue =

Connected vascular spaces (lined e' endothelial cells) These spaces are empty in flaccid penis & filled e' blood in erected penis. They are separated by smooth muscles, collagen & elastic fs. Corpus spongiosum is surrounded by more elastic fibres than corpora cavernosa.

Blood Supply of penis:

Dorsal & deep arteries. The deep artery gives 2 branches:

- ↳ nutritive → supply O₂ & nutrition.
- ↳ helicine a. → empty in the cavernous bl. spaces.

- Helicine arteries are spiral in flaccid penis & straight in erected penis.

- Arteriovenous shunts: connect the Helicine arteries e' the deep dorsal veins. They are the normal route of blood flow in the flaccid penis.

Mechanism of erection

* the parasympathetic causes:

- ① Closure of A-V shunts, so bl. in helicine as is diverted to the bl. spaces
- ② Relaxation of the sm.ms in:
 - (a) dorsal, deep & helicine as → ↑↑ bl. flow to the penis.
 - (b) trabeculae bet. the cavernous spaces → their distension.
- ③ The filled cavernous spaces compress the veins against the dense tunica albuginea blocking outflow of bl., so it is trapped in the spaces → rigid & erected penis.

Mechanism of ejaculation

* the sympathetic causes:

- ① Opening of the A-V shunts so bl. passes directly to the deep vs.

2

② Contraction of the sm.ms in:

- a) dorsal, deep & helicine as $\rightarrow \downarrow \downarrow$ bl. flow to the penis.
 - b) trabeculae $\rightarrow$ preventing distension of the cavernous spaces.
- This lowers the press. on the veins $\rightarrow$ draining the bl. from the penis $\bar{w}$ returns to the flaccid state.

(N.B) Corpus spongiosum does not become as rigid as corp. cavernosa during erection as tunica albuginea is thin & e' more elastic fs to avoid compression of the penile urethra during ejaculation

(V.B) Glans penis is covered e' a fold of skin prepuce rich in elastic fs. to retract during intercourse. The operation by $\bar{w}$ prepuce is removed = circumcision.

Impotence = inability to achieve erection. Causes:

- a) - temporary: psychological or drugs e.g. alcohol. or
- b) - permanent: lesion in sp. cord or brain, diabetes mellitus & Parkinson's disease.